Life, as we know it to exist today, could not do so without the cell membrane. Biological membranes are composed of a mixture of proteins and lipid molecules which surround each cell, as well as some sub-cellular "organelles", with a layer a few molecules in thickness. It is the membrane which sequesters the living and metabolizing protoplasm within and its immediate environment without. Why is the membrane a universal component ~~of~~ and a sine qua non in the biological machinery of life?

The universality of the membrane and its indispensible functions appear to go hand in hand.

Modern biol

The trend in modern biology is towards attempting to justify cell structure in terms of function. On the molecular level, many examples can be cited. The structure of chromosomes in general, and DNA in particular, is to direct the synthesis of certain proteins. Many of these proteins, in turn, can be isolated and are found to catalyze certain chemical reactions necessary for cell metabolism. Some of these enzymes require specific inorganic ions for activation. ~~The membrane is responsible for the permeability and non-permeability of many chemical species, including ions.~~ Those enzymes for which no function has been found, it is decided have one which as yet is undeterminable.

To answer this question, we must begin at the beginning. The beginning of life, itself, that is.

Many biologists are of the view that a closed membrane indeed initiated some of the preevolutionary processes. The first step in the evolutionary process, from a structural point of view was the formation of microscopic bags in the primeval sea. With time the composition and nature of the solution enclosed within these sponatneous membranes became different than the external solution. The next step was the development of catalyzed chemical reactions within the sacs, followed by the bursting of such sacs, reproducing other microscopic sacs, which retained the morphological and catalytic activity of their predecessors. A gradual development of this nature led to more complicated systems. At some further point of development, the molecular coding which we recognized today as universal gained predominance.

~~If this is the case, it points to two conclusions. The~~

Perhaps the membrane was necessary at the beginning of life

If this were the case, then the ensuing development of the cell was based on the structure of the membrane. Since the metabolic activity of the cell depended on what permeated the membrane and what did not, the metabolism evolved as a direct function of the properties of the said membrane. When we examine the properties of the membrane today, we find a correspondence between the properties of the membrane and the cytoplasm. But, indeed, the converse could be true: the cell do at least some of the properties

Which came first, the cell or the membrane?

There are three views. Those who believe that life arose as the result of an act of divine

of biological membranes dictate those of that which it encloses and not the other way around, that the membrane has evolved in response to the needs of the xxxxxxxxxx intracellular metabolism.

THERE are other biologists who believe that

On the other hand, there are membranes which fulfill more specialized functions than those that could be expected from a primitive membrane. For example, the membrane of the mitochondria carries out the respiratory process. Is this a process to be considered a primeval one? Moreover, the respiration systems of membranes of different organisms are xxxxxxxxxx developed to different degrees. xxxxxxxxxx More primitive organisms possess simpler respiration chains.

Another view is that membranes were superfluous to biogenesis. The xxxxxxxxxx Life could have begun in the form of condensed droplets of organic polymers. These droplets also constitute a separate phase from the solution, and are in some cases, capable of catalyzing certain internal reactions. In such a condensed globule, it is easier to picture the development of xxxxxxxx specific macromolecule synthesis, since the interaction between the different polymers is greatly increased. On the other hand, we know that cells today are completely different. If we rupture the membrane of a red blood cell, all of the contents spill out. xxx Although intracellular molecules may have varying degrees of organization, they are incapable of existing as a separate phase in the absence of the membrane. xxxx, If these "protenoid microspheres" represented the first life forms then its stands to reason that membranes evolved in a later stage, by adsorbing onto the already existant phase boundary.

If this were, the case, then, would it not stand to reason, that the membrane should have been an optional accessory to early cells, and that today, not all cells should have membranes.?

Not all cells have mitochondria, chloroplasts or even respiration chains.

Whether or not the membrane has dictated the conditions to which the cytoplasm has accustomed itself, and thus, must perforce, maintain, or the membrane has evolved to fit the needs of the viable cell, it does just that. But, the membrane in every different organism is composed of different proteins and different lipids, as well as in different ratios. Does the molecular composition throw light on the function?

This question is part of the more general one, did the DNA (or RNA) have to be the molecular carrier for the genetic code or was it a freak accident? Did proteins have to arise from polyamino acids?

In some cases we can demonstrate the variety of macromolecules which have evolved in order to accomplish the same task. Cytochrome C, a protein in the respiration chain has the same basic structure in all organisms, but there are many variations in the amino acids.

It would be impossible to build the same general type of cell membrane which exists today with neitherlipids nor proteins. On the other hand, we can build all sort s of membranes, for example synthetic.

Synthetic membranes share some characteristics with natural membranes. For exmple, cellophane membranes are premeable to water and small ions. These man-made membranes lack the flexibility of biological ions.

Another interesting feature of artificial membranes is that permeability, where it does occur, is dependent only on osmotic pressure and potential difference across the membrane.

We now move into a problem which is easier to visualize. Cell membranes are permeable to water. If bacteria without their rigid cell wall are placed in water, they very quickly expand and burst. Indeed, it is the cell wall which prevents them from bursting in their natural aqueous habitats. The bacterial cell wall, then, can be envisaged as an organelle whose purpose is to compensate for this innate property of the membrane. Were the membrane to be more rigid, if it were thicker and more polymerized it would not have the flexibility which membranes need to engulf food, or excrete hormones.

Another connected problem is the concentrationof water ih the living cell. Water comprises 80-90% of bacterial wet weight. When bacteria are dessicated, they weigh up to one tenth of what they weigh in solution. Why sucha great preponderence of water?

There are a number of possibilities. Since it is postulated that life began in the sea and only much later conquered the land and the air, it is evident that the composition of protoplasm of the early cells wasnot much different from that of the environment. Even when life left the ocean, its mechanism was such that it still required a large concentration of water in order for metabolism.

On the other hand, it could be that the cell had no choice but to assimilate large quantities of water. Since the cell membrane is so permeable to water, attempts to pump out the water would only bring in more water.

It is also arguable that for any metabolism to be viable, it would have to occur in aqueous solution. Any organic chemist knows that the same two chemicals which, when mixed in a common solvent,will react violently, will sit peacefully side by side if they are mixed as powders. As well, a gaseous metabolism is equally hard to visualize. Gaseous reactions emit shock waves which would rupture any delicate life vessel. As well, the permeability of gases through permeable structure is much to fast to regulate.

An anabogy can be drawn between life and Goldilocks who found that though Papa Bear's bed was too

hard and Mama Bear's too soft, Baby Bear's was just right.

Goldilocks also preferred Baby Bear's porridge which was neither too hot or too cold. Living organisms also have preferences in the temperatures in which they grow. Since liquid water is the major ingredient of life, the temperature range in which life is possible, as a first approximate, is that range in which water is liquid. We can narrow it down still further because at high temperatures proteins tend to denature. But at low temperatures, the membrane freezes, and loses its characteristic flexibility and some of its permeability characteristics. As a result, it has been found that there is a correlation in cold blooded animals between the minimum temperatures that they can survive and the freezing range of their membranes.